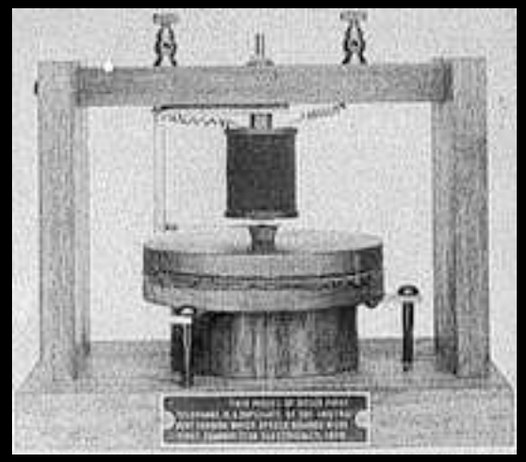
From Alexander Graham Bell to SIP

Russ Clark

August 24, 2009

Origins of Telephony



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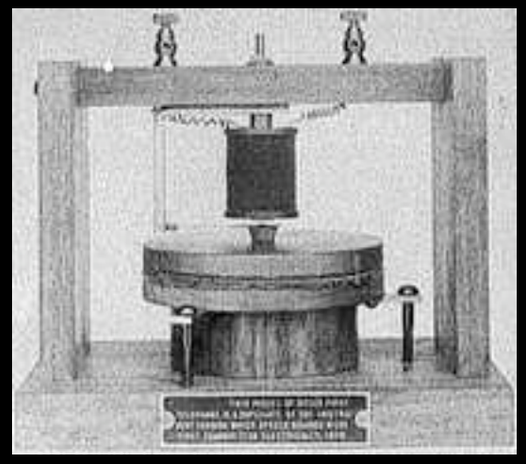

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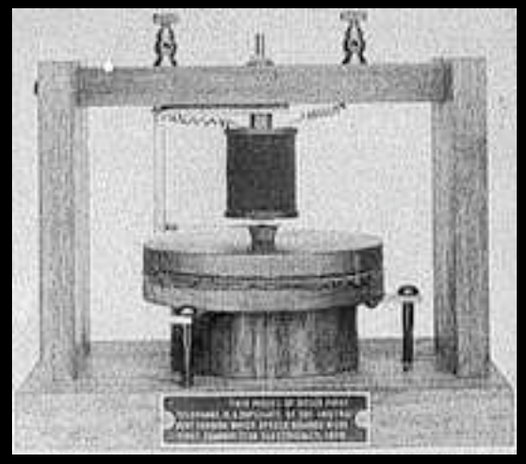

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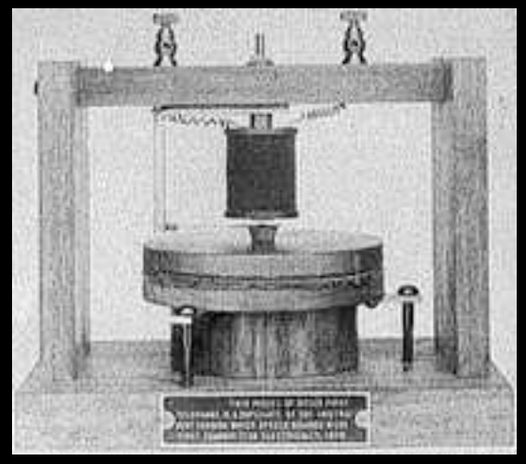

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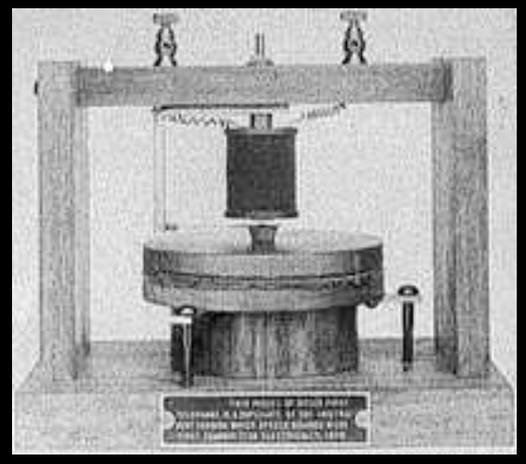

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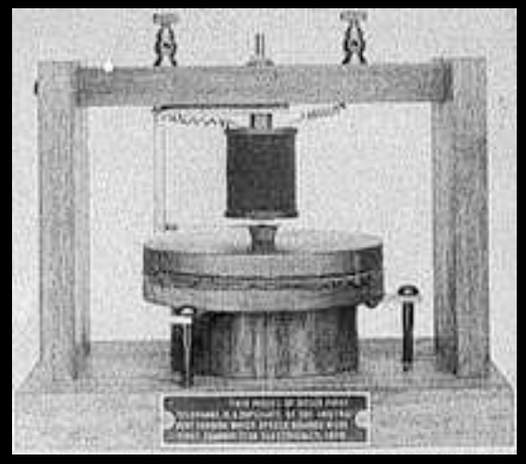

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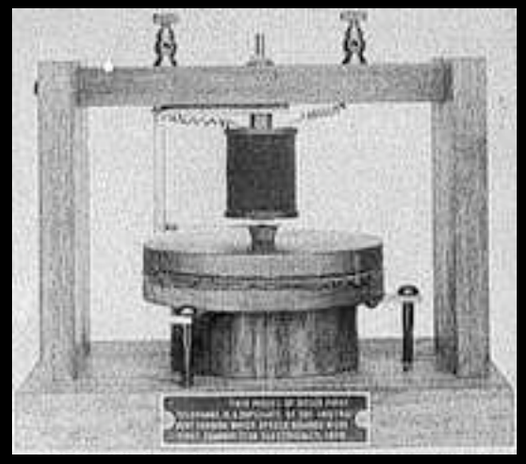

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- Dedicated circuit, point to point service
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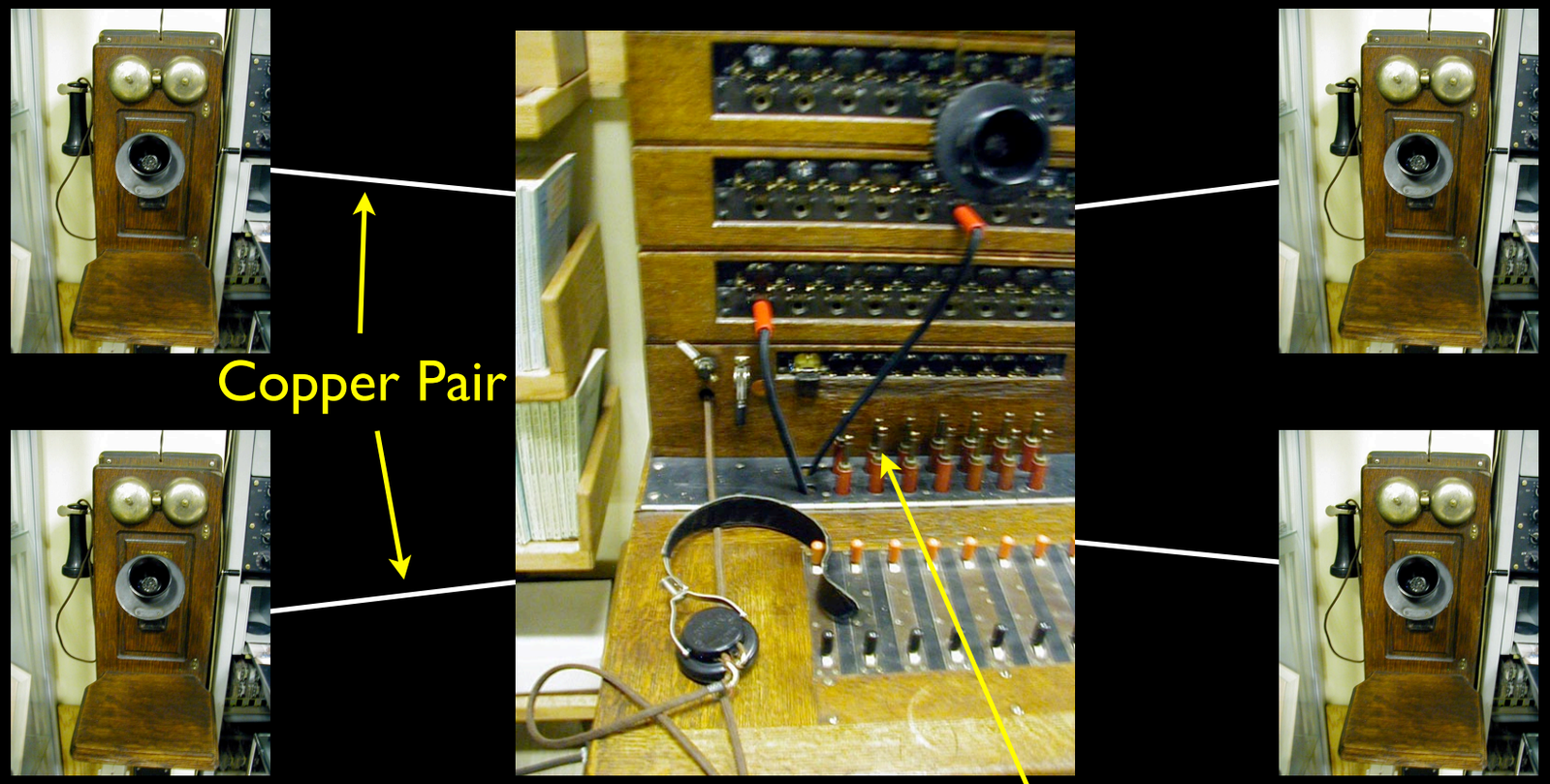
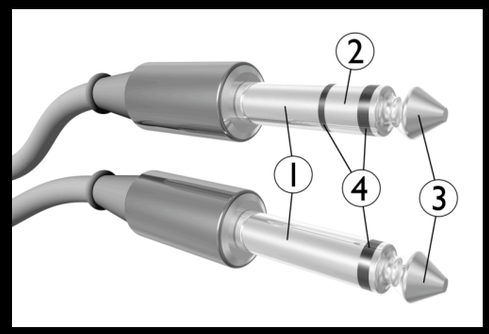
- 4 KHz, duplex audio service

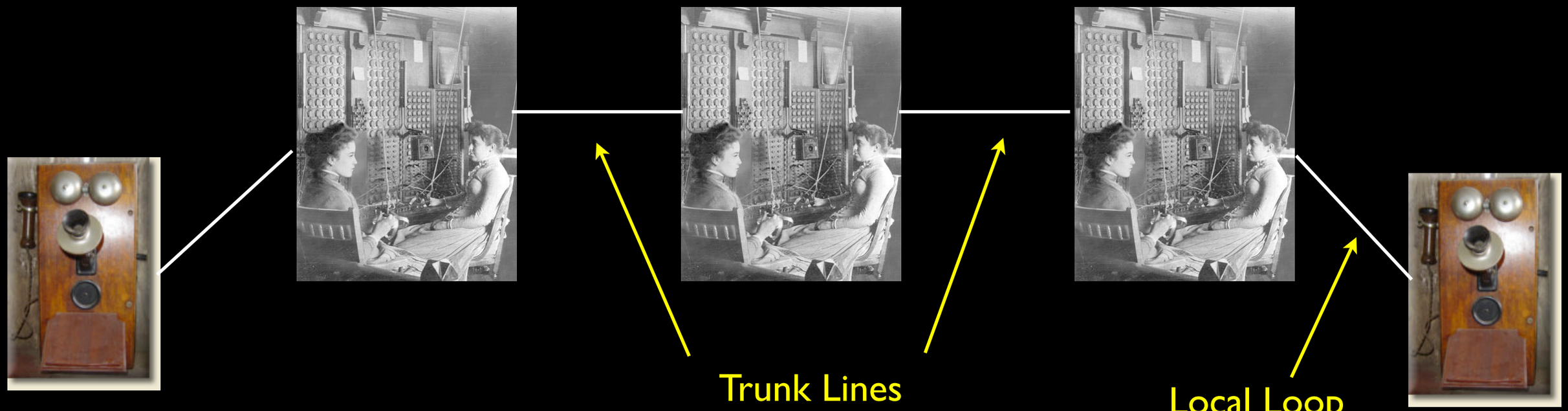
The Switchboard



- Human Operator
- Minimal signaling
  - turn the crank to ring the bell
  - tell the operator who you want to talk to
  - operator connects you with a patch cable
  - *In Band* Signaling

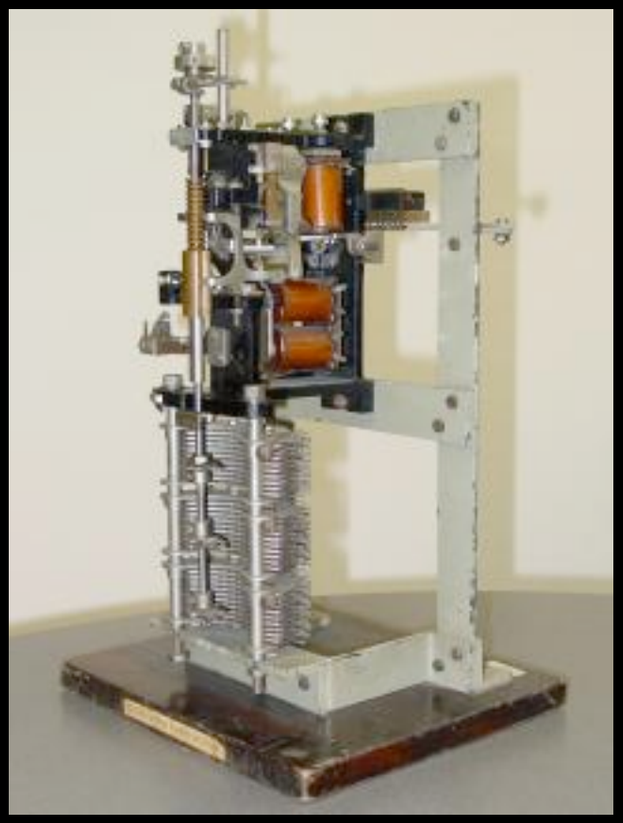


Long Distance with Operators



- Human Operators connecting one switchboard at a time
- Local loop lines distinguished from trunk lines
- Signaling is still the same: ring the bell and tell them where you would like to connect

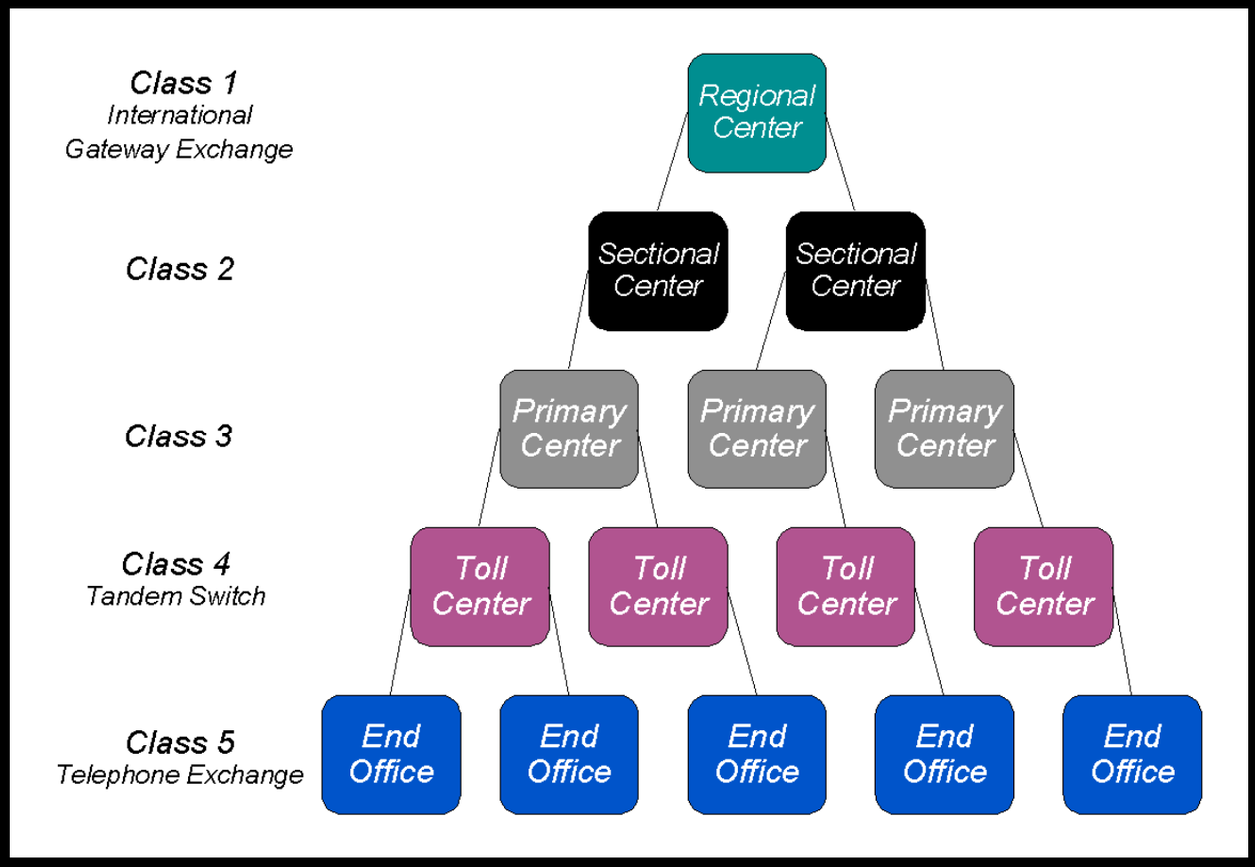
The Automatic Switch



- Patented by Almon Strowger in 1891
- Same basic design used for more than 60 years

- Invented because Strowger felt that the operator was not practicing Network Neutrality!
- Pulse dialing: numbers indicated by count of pulses
  - pulses cause switches to “step” up to appropriate location: the “Stepper switch”
  - In Band Signaling

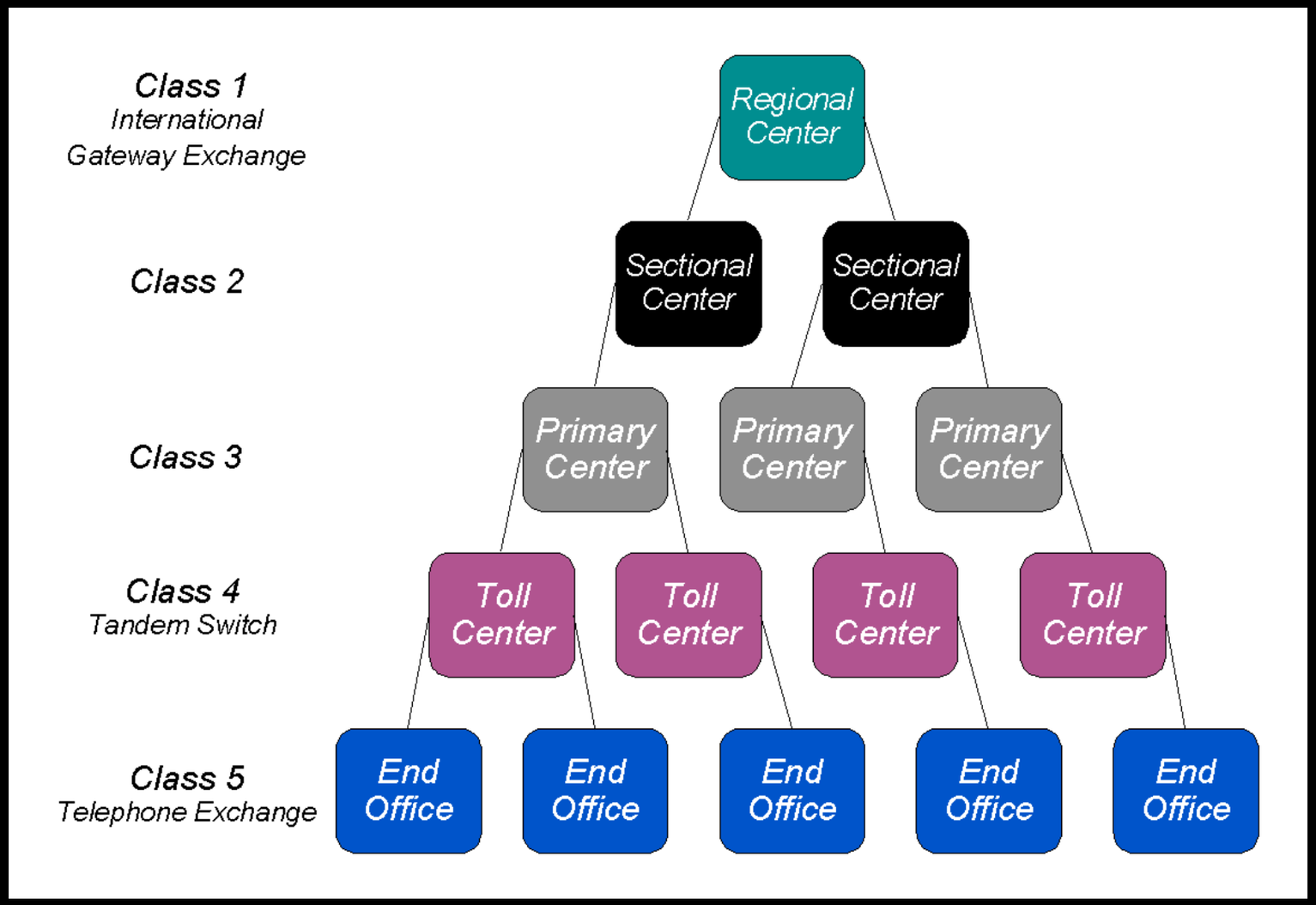
Hierarchical Network



	#
	10
	70
	200
	800
	3000

- Hierarchical routing architecture
- Designed to increase fault tolerance, minimize blocking
- 99.999% available - less than 5 minutes downtime per year on any given line/trunk
- .01 blocking probability
- statistical capacity planning - Erlangs

Hierarchical Network



- As capacity increases, additional tandem trunks can be added

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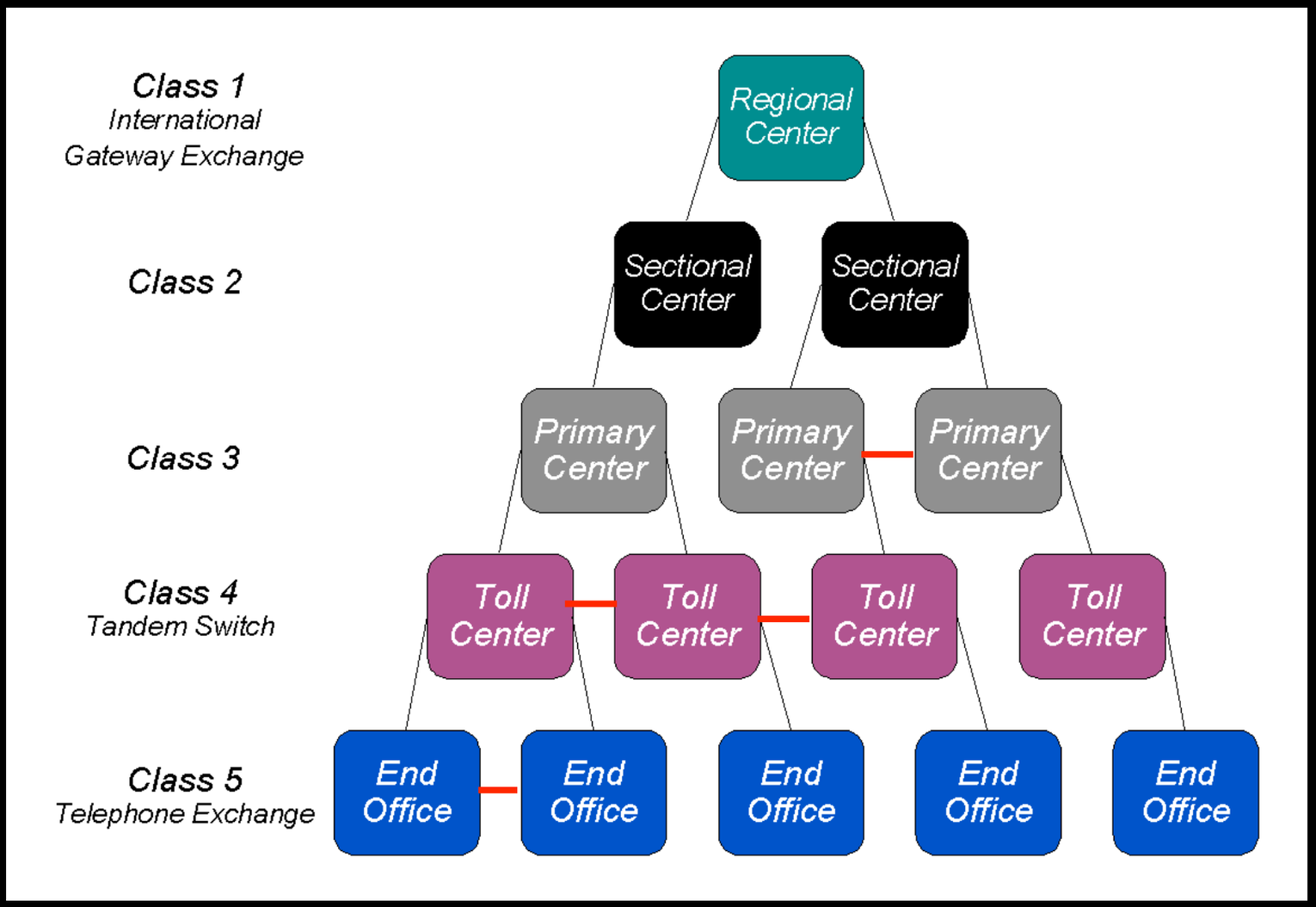

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In-Band vs Out-of-Band Signaling

- In-Band
  - Use the same infrastructure (wires and switches) for signaling and for voice
- Out-of-Band
  - Create a separate infrastructure for signaling

Problems with In-Band Signaling

- Voice and signaling don't require the same network features
- Single point of failure
- Toll fraud
  - security issues arise when users can inject control signals into the network
  - See Captain Crunch

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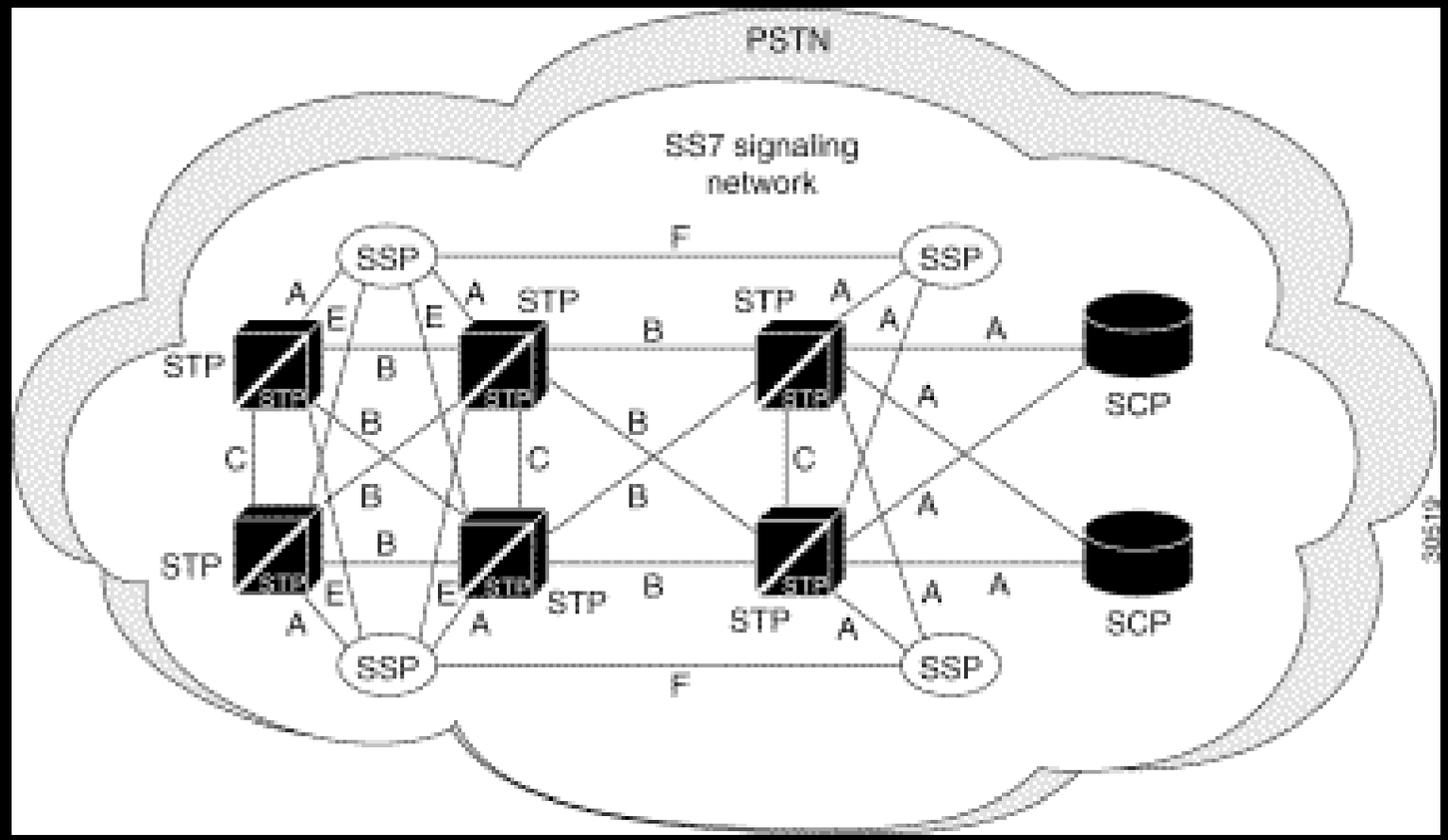
Common Channel Signaling (CCS)

- Use separate networks for the voice and signaling
- Also called "Out of Band Signaling"
- Developed in 1960's for network to network signaling
- STP - Signal Transfer Point
  - packet switches
  - originally 10 STP pairs across the country for thousands of voice switches

Signaling System #7 (SS7)



- The core signaling standard for US networks
- SSP - Service Switching Point - voice switches with SS7 control interfaces
- STP - Signal Transfer Point - call routing and control
- SCP - Service Control Point - databases of call feature and customer information

Advanced Intelligent Network (AIN)

- Move to software driven features
- A central database of signaling and service data
- Originally developed to support
  - 800 numbers
  - time of day call routing
  - map one number to another number
- In mid 1980's there were around 10 database servers deployed in pairs for reliability

Soft Switching

- Since the 1990's, there has been movement to true soft switching
- Separation of transport from Call Processing and Service Processing
- The IP Internet is the core "transport" for both signaling and voice
- Moving toward IMS: the handsets have become more sophisticated and powerful
- Need intelligent way of doing session control
- Development of SIP - Session Initiation Protocol and IMS

Telephony Characteristics

- 4 KHz Audio Channel
- POTS - Plain Old Telephone Service
- Physical Circuits have evolved to Logical Circuits but the basic service interface is the same
- Simple end-user devices, Intelligent network to provide advanced services
- Regulatory requirements
  - universal service
  - 5 9's reliability
- Sophisticated charging and billing architectures

Telephony Historical Themes

- Separation of signaling and control from voice
- Focus on core voice service - QoS
- Transition from analog to digital
  - first in the core trunks
  - then the switches
  - now moving to the edges
- Increasing intelligence inside the network to provide new services
  - keep the changes to the handset minimal
  - centralize management and control
  - capture revenue

Contrast This With Traditional IP Services

- One channel for for data and control (e.g. TCP, SNMP, DHCP, RIP,BGP)
- It's always been digital, analog data is digitized before use
- Simplicity in the core, IP routing, *best effort* datagram services
- Complexity and features are implemented at the edges
  - clients and servers
- Data transport is billed at a flat rate
- Service (application) billing is not part of the network

The IP Multimedia Subsystem - IMS

Bridging these two worlds

Telco

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Internet

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- Complexity and features are implemented at the edges
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- Data transport is billed at a flat rate
- Service (application) billing is not part of the core network service